BOOK REVIEW

Recent Advances in Cytology[1]

It was only yesterday that Virchow's dictum *Omnis cellula e cellula* crystallized into definite form a series of observations upon the cell. The cell became a measuring rod for a vast unexplored continent and the discoveries made are permanent records of achievement. The cell possesses an organization, all of whose parts cooperate. Cytoplasm, delimiting membrane, nucleus, and plastids together with substances entering, substances leaving, substances synthesized, substances broken down—a series of actions and interactions, nullification of one, retardation of another, acceleration of a third, express in the cell what we call life. Can anyone say which part is more alive than another? Cytoplasm? Cell wall? Plastids? Nucleus? Nucleolus? Centrosome? Spindle fibers? Chromosomes? Are the chromosomes alone the bearers of hereditary qualities? What have been the contributions of the students of cell lineage? Have we forgotten the promorphological properties resident in the cytoplasm of the egg? How about the forces outside the cell? Have they no effect upon morphological expression? Morphogenetic forces inside the cells, morphogenetic forces outside the cells—cells and tissues and organs mutually influencing and modifying one another. A glorious array of solid achievement in less than a century!

A new generation has arisen and it has fashioned for itself a new set of values, using little of the old, freeing itself from many of the supposed factual ties with the past. And were great trailblazers like Flemming and Strasburger, dead only a few years, to return, they would be akin to Rip van Winkle aroused from a long slumber to find that the world had passed them by. The lardmarks that they knew are no longer there—strangers in their own land. The sign posts in Darlington's cytology do not suggest connections with the highways of von Mohl, Naegli, Fol, Buetschli, Hertwig, Strasburger, Flemming, Boveri. Modern cytology begins with the year 1912!

The foreword to the book is written by J. B. S. Haldane who

[1] Recent Advances in Cytology—Darlington, C. D. P. Blakiston's Sons & Co. Philadelphia, 1932.

informs the reader from the very outset that: "This book on karyology marks the beginning of a new epoch, the transition from an essentially descriptive to a largely deductive science. . . . It finds its parallel in the study of the fixed stars. The average cytologist is primarily an observer and unaccustomed to long chains of deductive reasoning. He will find the book extremely difficult. . . . The chromosomes are not only astonishingly similar in all organisms but are mainly responsible for diversities of teeth and xylem. And their study immediately discloses a whole set of new evolutionary principles which are hidden from the macroscopic morphologist."

Then follows the mapping out of the heavens of the new cytology by Darlington. The instruments are in his hands. It is he who with a consummate knowledge of experimental genetics casts his eyes upon the nucleus and studies its stars and planets. He marks their position, apportions their sizes, plots their orbits, determines their magnitudes, and charts their constellations. From the shades of color in the eye of Drosophila, from the proportions of a squash, from the varying spines of a Jimson weed he deduces when they must attract and when repel one another, when there is partial or total eclipse, and when they shall collide, and when they must fragment.

There are still two kinds of nuclear divisions for Darlington —as he calls them simple and double mitosis. Double mitosis is really an abnormality of simple mitosis. It is called meiosis. Chromosomes are two-parted and the preparation for the division of the nucleus does not lead to the formation of a spireme. The spireme concept is untenable on cytological and genetical grounds.

The two parts of the chromosome (chromatids) correspond exactly part for part, chromomere for chromomere. The chromosomes preserve their identity throughout all stages of mitosis and during all succeeding division at succeeding mitoses. The chromatids are cylinders and the chromomeres are arranged in a single spiral. All chromosomes have one constriction unless it is terminal. The spindle attachment always coincides with a constriction. The constriction is a point of weakness in the chromosome. Constrictions give diversity of form to metaphase chromosomes and therefore character to individual chromosomes. Chromosomes of one race because of their constant morphology

may be recognized even though they may have entered into a genetic union with those of another race or species.

Meiosis is defined by Darlington as two divisions of the nucleus accompanied by one division of its two-parted chromosomes. It is at meiosis that the final evidence of chromosome pairing in hybrids and non-hybrids, in polysomes, and in polyploids occurs. It is the time when the results of fertilization can be evaluated. That meiosis takes the complicated course that it does in nearly all sexual plants and animals, has one object: "it provides the conditions for crossing over without which recombinations of genes and secondary structural changes in the chromosomes would be excluded. Meiosis has no virtue except in hybridity. Gene changes on the one hand and proportion and quantity changes on the other hand are essential agents in evolution."

The pendulum swings back and it has retreated two hundred years in time. The discarded preformationist has been resurrected, he is now in our midst—modernized to be sure—yet a dominating figure. The chromosomes retain their individuality, in them alone are the units of heredity, the genes. In the nuclei are the predetermined representations of the generations yet to be. The geneticist and cytologist have mapped out the chromosomes assigning definite places to the hundreds and thousands of genes responsible for form and function. And just as the preformationist of the 17th and the 18th centuries saw in the egg the preformed chick, so does the cytogeneticist see the characters of stem, leaves, flowers, roots, tissues, eyes, wings, color, and their endless morphological and physiological attributes in the chromosomes of the egg and sperm.

The role of the cytologist—the student of the physiology of the cell has become more and more circumscribed. The edifices that he laboriously erected have fallen into disuse and are no longer esteemed. He has been forced to retreat from position to position, giving up ground all the time. The cytoplasm and its inclusions have been abandoned. Taking inventory of his wares the cytologist finds that all that he has left now, are chromosomes and spindle fibers. His transactions are with these two commodities. Genetics and cytology have entered into an indissoluble bond; they have erected a new preformationist doctrine.

And yet, in sexual reproduction, there is the inescapable phenomenon that two cells, two whole cells, not merely chromosomes, two cell organizations unite and from that intimate union of all parts of the gametes—*omnis cellula e cellula.*

Cecil Yampolsky
Botany Department, Columbia University

FIELD TRIPS OF THE CLUB

Trip to Nepera Park and the Boyce Thompson Institute on March 25. A party of thirty was met at the Boyce Thompson Arboretum by Mr. J. H. Beale and taken through the nursery where a great variety of trees and shrubs are growing. Some of the heathers were already in blossom, a planting of *Erica carnea* showing as a bright patch of pale purple on the hillside above the nursery. From the nursery the party followed a new road to the top of Sprain Ridge, noting the planting that had been done on the summit of the ridge and at the edge of the woods. Dead and dying trees in the woods have been cut out, otherwise the woods are in their natural condition. Few flowers were in evidence,—a few blossoms of periwinkle, *Vinca minor*, where it had become established in an open place, a dandelion or two and the catkins of alder and hazelnut comprised the total. The gray pussies of large-toothed aspen were well grown, but not yet shedding pollen. In the afternoon the party visited the Boyce Thompson Institute where Dr. P. W. Zimmerman explained some of the work being done in the laboratories and greenhouses. Much interest was shown in the experiments of using wastes from pulp factories, chiefly lignin, for mushroom culture instead of manure. The initiation of root growth on cuttings by treatment with carbon monoxide was very striking and led to a discussion as to the effects of the gas on plants and animals. The effect of oxygenating water in which cuttings were being rooted was equally striking, the stems in cylinders through which oxygen was bubbling being covered with roots from the surface of the water to the bottom, while those in the control cylinders had comparatively few roots and those all near the surface.

George T. Hastings